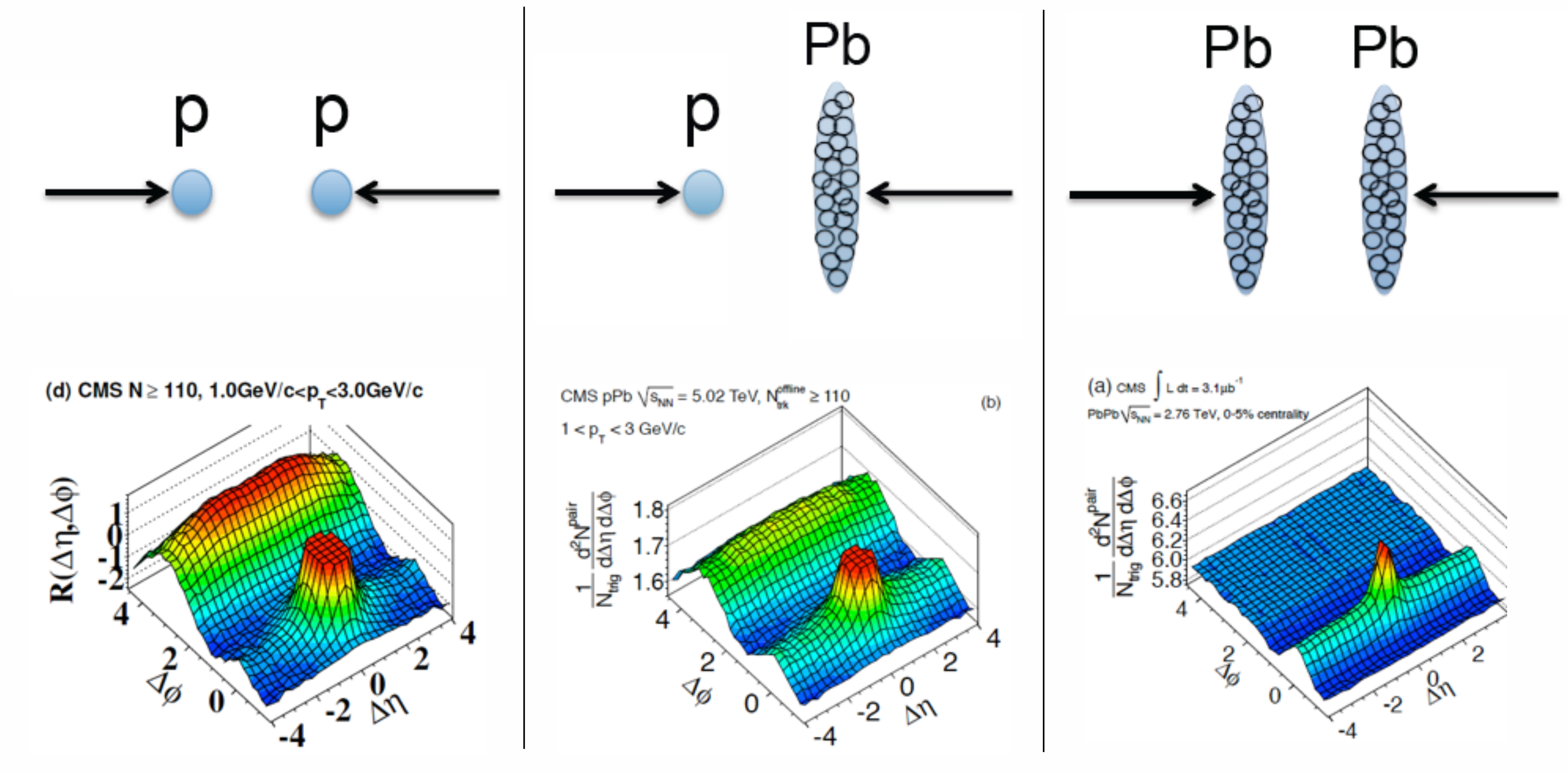
A “Ridge” and Other Anisotropies in e+A

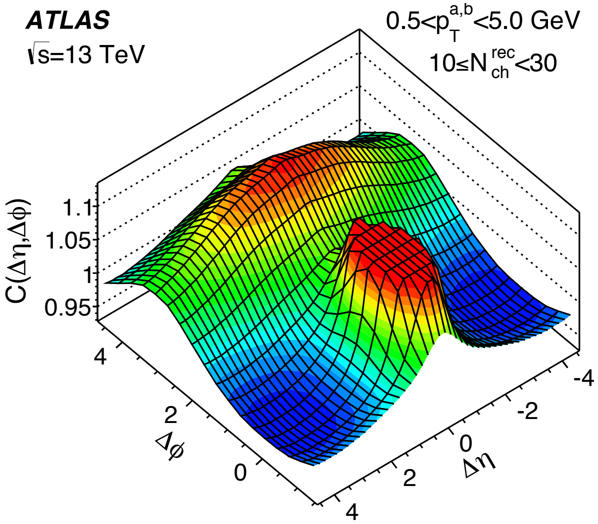
(not even a draft)

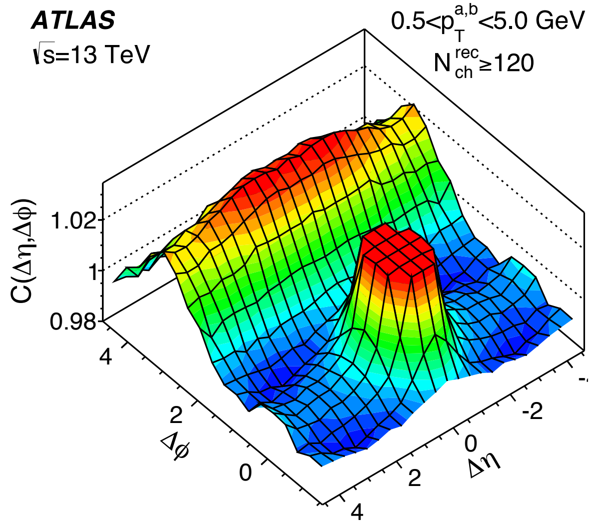
TU, October 15, 2015

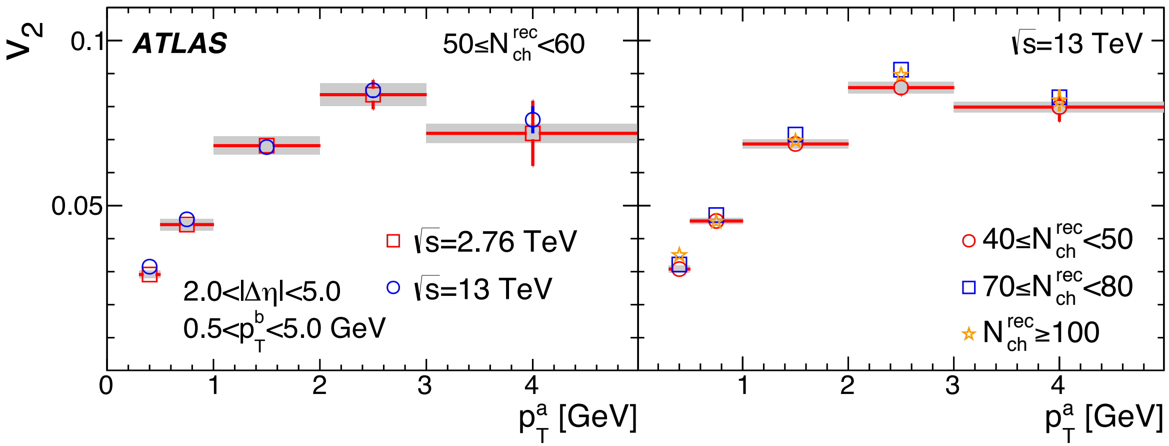
Ridges everywhere: pp, pA, AA

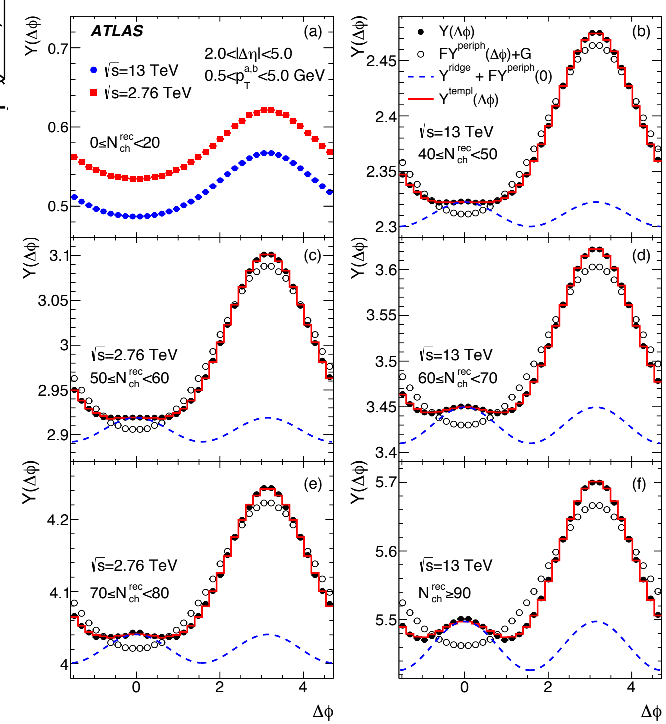


13 TeV pp at LHC (hydro/CGC?)









The distribution of linearly polarized gluons and elliptic azimuthal anisotropy in DIS dijet production at high energy

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We determine the distribution of linearly polarized gluons of a dense target at small x by solving the B-JIMWLK rapidity evolution equations. From these solutions we estimate the amplitude of $\sim \cos 2\phi$ azimuthal asymmetries in DIS dijet production at high energies. We find sizeable long-range in rapidity azimuthal asymmetries with a magnitude in the range of $v_2 = \langle\cos 2\phi\rangle \sim 10\%$.

Transverse momentum dependent (TMD) factorization [1, 2] in deep inelastic scattering predicts a distribution for linearly polarized gluons in an unpolarized target [3, 4]. This is reflected in $\cos 2\phi$ asymmetries in dijet production [5, 6] and in other processes [7–9]. To date little is known about the magnitude of these functions in the small-x regime of high energies. In this paper we perform first estimates of these functions by solving the B-JIMWLK renormalization group equations [10–21]. Also, we use our solutions to analyze the magnitude of the resulting $\cos 2\phi$ asymmetry in dijet production [5, 22] at leading order. These could be tested at a future electron-ion collider (EIC) [23, 24], where the small-x effects discussed here can be enhanced by using a nuclear target.

Recent data for high multiplicity p+p [25, 26] and p+Pb [27–33] data at the LHC have revealed long-range (in rapidity) angular $\cos 2\phi$ "ridge" correlations in particle production high multiplicity events. The magnitude of these long range correlations is conventionally parametrized in terms of $v_2 \equiv \langle\cos 2\phi\rangle$. In fact, the azimuthal correlation in DIS dijet production at high energy originates also from the long-ranged eikonal interaction and so results in a similar experimental signature as the "ridge". To make this connection explicit we shall parametrize the azimuthal structure arising from the linearly polarized gluon distribution in terms of $v_2 = \langle\cos 2\phi\rangle$, and determine its dependence on the rapidity imbalance of the dijet.

At leading order the cross section for inclusive production of a dijet in γ^*-nucleus scattering is given by [5, 6]

Predict for eA substantial v_2

As with Bowen (dihadron suppression), here dijets=dipartons~dihadrons

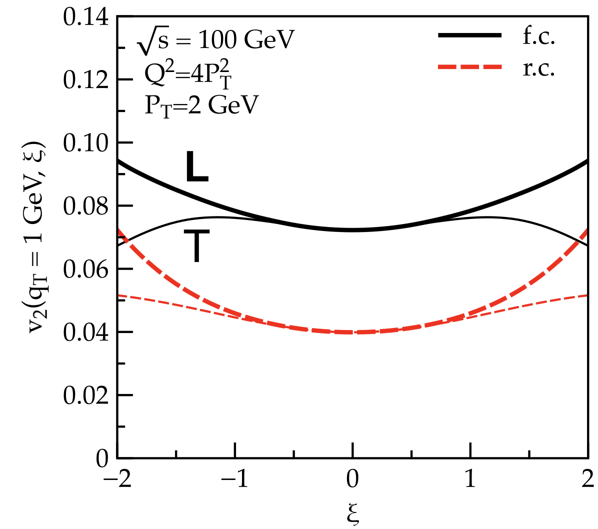
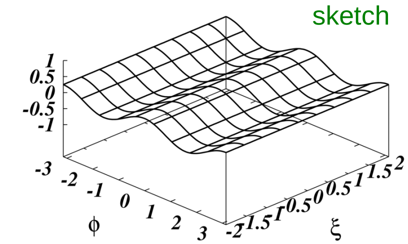


FIG. 3: The average azimuthal anisotropy $v_2 = \langle \cos 2\phi \rangle$ versus the dijet rapidity imbalance $\xi = \log\ (1-z)/z$. Thick (thin) lines correspond to longitudinal (transverse) photon polarization.



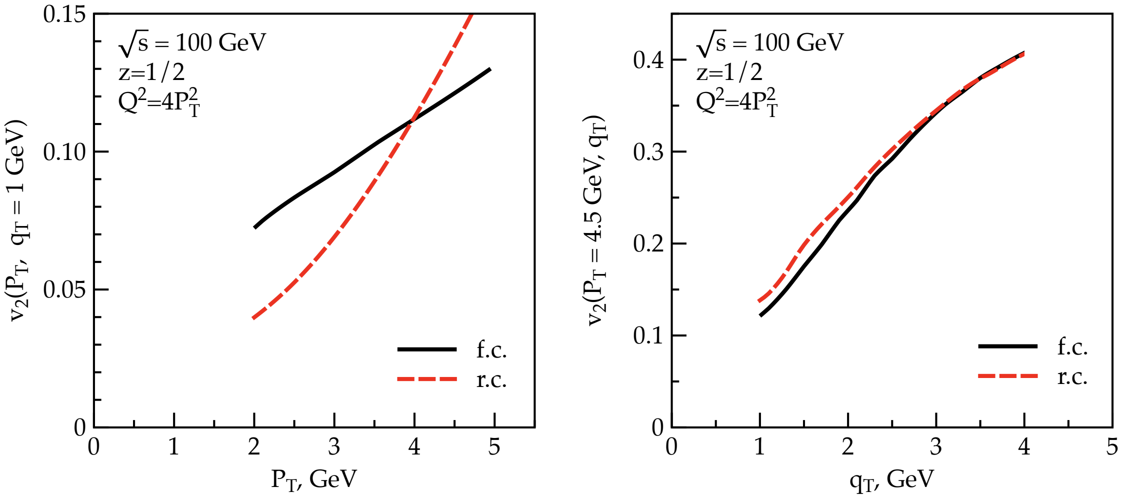
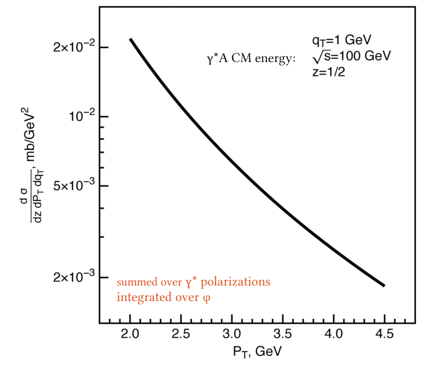


FIG. 2: The average azimuthal anisotropy $v_2 = \langle \cos 2\phi \rangle$ versus the dijet transverse momentum scale P_T or the dijet transverse momentum imbalance q_T, respectively. The assumed $\gamma^* A$ center of mass energy is $\sqrt{s} = 100$ GeV. Since $Q^2 = 4P_\perp^2$ and $z = 1/2$ these curves apply to either longitudinal or transverse photon polarization. Solid (dashed) lines correspond to fixed (running) coupling evolution.

Testing the feasibility

- Other than in Bowen's case Adrian and Vladimir provided a MC code
  - standalone C++
  - produces hadron pairs
    - pt, qt, z, phi, \vec{kt1}, \vec{k2}.
    - basically, pt is the total dijet transv. momentum, qt is the tr.mom. imbalance, z is the light-cone momentum fraction of the produced quark, 1-z that of the anti-quark, and phi is the angle between \vec{Pt} and \vec{qt}. to see the "ridge", you basically need to plot dN/dphi vs phi.
  - Issues:
    - No cross-section just pairs (Adrian is fixing this now using Sartre experience and code)
    - for fixed A only (Qs fixed) but OK since A=200, can be fixed according to Adrian (not urgent)
    - for L and T separate and fixed γ*A √s
      - need eA not γ*A
    - no parton shower (could be added via PYTHIA8)

Magnitude of cross-section (angular integr.)



Next steps

- Let Adrian and Vladimir add CS and photon flux incl. T,L dependence
- Invite Vladimir to give a talk (RBRC!)
- TU (add parton shower)
- Then run through set det. sim or use fast sim and study effects (ridge?)
- Compare to PYTHIA with EPS09? Use Liang’s MC?